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ABSTRACT

The Cable Television Information Center, as part of its overall attempt to provide local governmental policy makers with the information and analytical tools needed for sound decision making, prepared a report to assist public officials who wish to develop technical standards for cable television (CATV) systems in their communities. The report develops a comprehensive set of standards, discusses how it affects CATV system economics, and suggests alternative means of enforcement. Specifically, it recommends a regulatory program which is demanding but not beyond the present state of the art and which consists of the following elements: 1) construction standards to ensure a safe and reliable system; 2) technical standards for the reception of broadcast television signals received either off-the-air or via microwave; 3) technical standards for ensuring overall system performance; 4) procedures for testing system performance to ensure that all technical standards are being met; and 5) a record keeping log book that supports the technical standards and testing procedure programs. (Author/LB)

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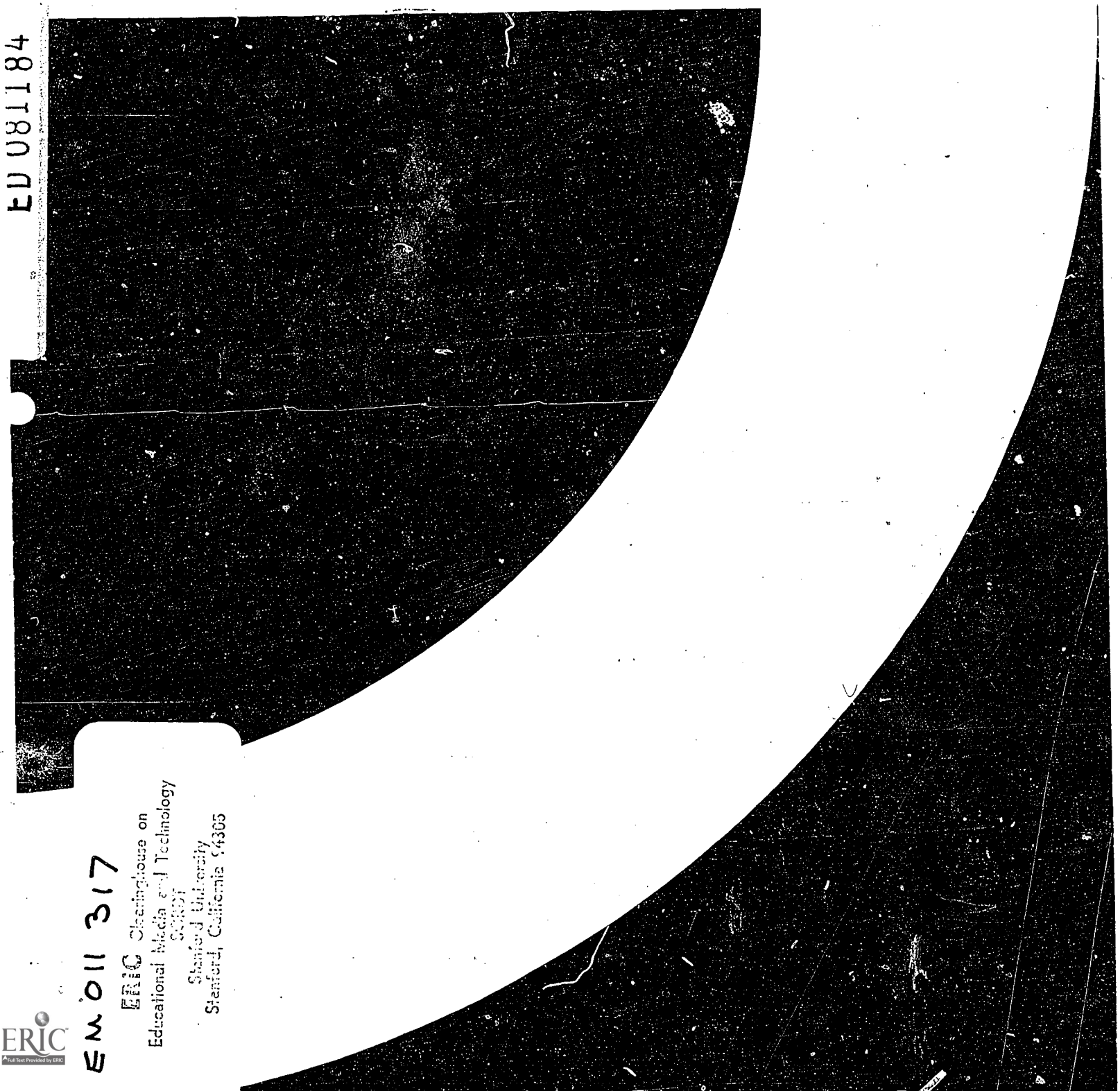
Technical Standards and Specifications: Ordinance Supplement Section VII



TECHNICAL STANDARDS AND SPECIFICATIONS:

Ordinance Supplement Section VII

CABLE TELEVISION INFORMATION CENTER
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PREFACE

This document was prepared by the Cable Television Information Center under grants from the Ford Foundation and the John and Mary R. Markle Foundation to The Urban Institute.

The primary function of the center's publications program is to provide policy makers in local and state governments with the information and analytical tools required to arrive at optimum policies and procedures for the development of cable television in the public interest.

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INTRODUCTION

The issues involved in developing and enforcing technical standards for cable television systems pose a number of problems for local governments. First, there are few sources to which a community may turn for comprehensive examples of reasonable technical standards. Second, technical standards are inextricably tied to cable television system economics and, hence, require the balancing of the desirable against the reasonable. Third, technical standards, obviously, affect system performance and public satisfaction; less obviously, they affect the future development of uses for cable television systems.

This report is intended to assist public officials who wish to develop technical standards for cable television systems in their own communities. It attempts to develop a comprehensive set of standards, to discuss how they affect cable system economics, and to suggest alternative means of enforcement. It can stand alone, but it is also intended as a replacement of Section VII of "How to Plan an Ordinance."

However, this document's format differs considerably from previous sections of "How to Plan an Ordinance." In that report, alternative examples of regulatory provisions adopted by various municipalities were cited in order to give those planning an ordinance a set of options which suits their particular needs.

This supplement provides fewer alternative provisions. The change in format does not arise from center conviction that these standards are correct for every situation; reasonable men will stand on both sides of this question. Rather, the major reason for the change in format is the center's judgment that the policy issue for most franchising authorities is whether or not to have standards other than those required by the FCC—not questions of one standard versus another.

Enforcement of the standards is another matter. Local franchising authorities should have no difficulty choosing among procedural alternatives for testing and enforcement. Accordingly, the section in this paper dealing with proof of performance testing and records offers a range of options.

Included in the discussion of each option is an analysis of the likely cost burden of the testing program, for both the system operator and the franchising authority. The reason for providing these analyses is this: the technical standards themselves represent reasonable industry practice in system design, and therefore should not impose an extra financial burden on responsible operators. Test programs, however, do cost money, and are proportionately more expensive for small systems and for small cities. Public officials can only responsibly decide upon technical standards testing programs when they know the programs' cost.

Furthermore, technical standards do not enforce themselves. Enforcement requires testing of the system, evaluation of the tests, and deciding upon corrective actions required. These activities add to the administrative burden of regulation. A franchising authority should not adopt standards unless it is willing to shoulder the burden of enforcement.

Franchising authorities should weigh the desirability of a local government standards program, as discussed immediately below, against the cost of enforcement of both the system operator and the local government. For small systems—and small

local governments—an initial plus an annual test program may be appropriate. For larger systems and cities, monthly tests may also be warranted. The decision to adopt standards and enforce them, or instead to leave technical standards in the hands of the FCC and the market place, depends upon local circumstances, and ultimately must be a matter of judgment.

The Importance of Technical Standards to Local Government Officials

It is possible to leave the enforcement of system performance to the influence of the market place. The subscriber, who is the ultimate consumer of cable service, may discontinue service if the quality of that service is poor. Theoretically, if the system operator begins to lose subscribers, attempts would be made to improve the system's performance.

However, there are several reasons why the franchising authority should assume a role in the development and enforcement of technical standards. In the first place, the technical standards set by the Federal Communications Commission in Subpart K of the February 1972 *Cable Television Report and Order* are not considered comprehensive by the commission. Moreover, the commission does not preclude the establishment of more restrictive requirements by local governments. In its reconsideration of the *Report and Order*, the commission stated:

> The general question of federal pre-emption of technical standards has been informally raised by a number of parties. Our technical standards provide only a start. They will be expanded to meet changes in the state of the art. We see no reason why franchising authorities may not now require more stringent technical standards than those in Subpart K.[1]

Franchising authorities faced with decisions now may not wish to wait for further commission deliberation. Also, at the time of this writing, some states have already developed technical standards for cable systems, and several others are contemplating such action. Franchising authorities should refer to appropriate state regulations before incorporating the suggested code contained in this supplement.

In addition, the FCC does not consider its measurement procedures an adequate guarantee that system performance standards will be met. The rules require that each system be tested annually, and that measurements be taken at three widely separated points. In its report, the committee stated:

> Many advised that requiring performance measurements at only three vaguely defined points would fall short of rigorously testing the system. Consideration has been given to requiring measurements at more than three points in order to insure "representative" sampling of system performance. But our view is that this requirement is not intended to establish that each subscriber will receive service in accordance with the standards—that can come only with a measurement at each subscriber terminal. The performance check is, rather, assurance to the operator and to the Commission (should the performance be questioned) that the signal path from headend to check point is capable of conforming to the standards. We are therefore retaining the proposed requirement for three measurement points. *Many systems, as a matter of good practice, will make routine observations at more than three points.* The ultimate requirement, in

[1] *Reconsideration of Cable Television Report and Order*, 36 FCC 2d 359 (1972)

> any event, is that the technical standards must be met at each subscriber terminal.[1]

A franchising authority may wish to set forth measurement procedures that give reasonable assurance to local officials that standards are in fact being met.

The establishment of technical standards by local governments is desirable for other reasons. An initial high signal quality may, over time, slowly degrade to a point where the signal quality is not acceptable. Subscribers who are unhappy with the quality of service may not regard discontinuing service as an acceptable alternative, especially if off-air television reception in the community is poor. Finally, the quality of system performance may have a long range impact upon future system capability.

The franchising authority also has an interest in seeing that cable television facilities are safely constructed and operated, and that the system's component parts are durable and reliable. Several federal agencies have set forth regulations that deal with such issues, but no comprehensive standard for safety, ruggedness, and reliability in cable television systems exists in one place. Therefore, the franchising authority may choose to set forth more comprehensive standards, as discussed in Section A of this report.

Finally, technical standards work no magic by themselves. A system operator has little incentive to adhere to a comprehensive testing program if the system's records are not examined by the franchising authority. In a letter to the president of a cable television company, the chief of the FCC's Cable Television Bureau suggested the commission's view of local governments' responsibilities with regard to technical standards.

> The Commission will not, however, assume responsibility for enforcement of more stringent technical standards. Local authorities should therefore be prepared to assume the burden of such enforcement.[2]

Hence, included in this supplement are suggested procedures for testing the cable system's technical performance, and sample record keeping forms.

Overview

The performance, safety and reliability standards, procedures for testing the system to ensure that these standards are being met, and record keeping requirements set forth in this supplement to "How to Plan An Ordinance" are more comprehensive than those required by the commission. Yet, they do not exceed the present state of the art. They are designed to provide local franchising authorities with a regulatory structure that will assure that subscribers will receive the best quality of service that the existing cable hardware is capable of producing economically.

Specifically, in this supplement the center recommends a regulatory program consisting of the following elements:

- construction standards to ensure a safe and reliable cable system
- technical standards for the reception of broadcast television signals received either off-the-air or via microwave
- technical standards for ensuring overall system performance
- procedures for testing system performance to ensure that all technical standards are being met

[1] *Cable Television Report and Order*, 36 FCC 2d 199 (1972) (emphasis supplied)

[2] Letter from Sol Schildhause, Chief of the Cable Television Bureau, FCC, to Edward M. Allen, Western Communications, Inc., August 11, 1972.

— the development of a record keeping log book that supports the technical standards and testing procedure programs.[1]

It is our hope and intention that through the development of comprehensive regulatory programs of this kind public officials may do much to assist the technology of cable television to realize its potential for public good.

A. CONSTRUCTION STANDARDS AND SPECIFICATIONS

Construction specifications for cable television systems focus upon two elements: system safety and system reliability (cable television system design specifications are contained in Section VI of "How to Plan an Ordinance"). A cable system which is designed to meet very high technical and performance standards will not function properly if an antenna breaks the first time it snows or if amplifiers "short out" during the first rain.

1. System Safety

The development of safety specifications in a cable TV ordinance permits the municipality to observe, check, and monitor to ensure system safety. While this aspect of the ordinance is not directly related to system performance and quality of signal received, it is, nonetheless, important. The construction of a cable system involves some degree of coordination and cooperation between such municipal departments as highways (rights of way), utilities (pole agreements), engineering (electrical standards), and federal agencies (e.g., Federal Aviation Agency for tower permits). As such, those standards relating to the quality of construction can be specified in the ordinance although it is not necessary to do so. The franchising authority may also want to examine local codes to determine whether any of them might affect cable.

In many cases, the standards applicable to cable systems will have been derived from non-cable related sources and standards. Local governments should note that neither the Department of Commerce nor the Electronic Industries Association assumes responsibility for enforcing either the construction, installation, or maintenance standards for the tower construction standards referred to in provision A.01(a) and (b), which follows. Hence, the enforcement of these standards is wholly the obligation of the franchising authority.

Those sections of the following provision pertaining to installation and physical dimensions of towers and the marking and lighting of antenna structures are federal regulations (A.01(c) and (d)). The enforcement of those sections ultimately falls to the appropriate federal agency, although local governments can include such requirements in their regulatory ordinances.

Congress passed the Occupational Safety and Health Act in 1971 to "assure as far as possible every working man and woman in the nation safe and healthful working conditions." It applies to all businesses with one or more employees. The Occupational Safety and Health Administration (OSHA) was established within the Department of Labor and empowered to set and enforce standards. A broad duty clause requires that all employers furnish employees with a workplace free from recognized hazards likely to cause death or serious harm.

[1] *Unless otherwise noted, records are required only where substantive standards of performance or safety* have been established.

Suggested Provision:

A.01(a)[1] Methods of construction, installation, and maintenance of the City's cable television system shall comply with the National Electrical Safety Code, *National Bureau of Standards Handbook 81 (part 2)*, National Bureau of Standards, United States Department of Commerce, November 1, 1961, to the extent that such Code is consistent with local law affecting the construction, installation, and maintenance of electric supply and communications lines. To the extent that such Code is inconsistent with other provisions of this franchise or with local law, the latter shall govern.

A.01(b) Any tower constructed for use in the City's cable television system shall comply with the standards contained in *Structured Standards for Steel Antenna Towers and Antenna Supporting Structures, EIA Standards RS-222-A* as published by the Engineering Department of the Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C. 20006.

A.01(c) Installation and physical dimensions of any tower constructed for use in the City's cable television system shall comply with all appropriate Federal Aviation Agency regulations, including, but not limited to, *Objectives Affecting Navigable Airspace*, 14 C.F.R. 77.1 et. seq., February 1965.

A.01(d) Any antenna structure used in the City's cable television system shall comply with *Construction, Marking, and Lighting of Antenna Structure*, 47 C.F.R. 17.1 et. seq., September 1967.

A.01(e) All working facilities and conditions used during construction, installation and maintenance of the City's cable television system shall comply with the standards of the Occupational Safety and Health Administration.[1]

2. System Reliability

It is desirable to ensure that the cable system, once operational, maintains a high degree of reliability. Periodic system failures due to poor design, poor construction, or poor equipment can significantly affect the potential impact of cable. High reliability can be ensured through a careful specification of required construction practices, as well as through periodic testing (see Section D). The development of suggested ordinance provisions relating to construction reliability deal with antennae, grounding and installation specifications for both aerial and underground construction, as well as for coaxial cable. Some of these suggested provisions are included principally for the benefit of the cable system operator. Compliance with these provisions does, however, inure to the benefit of the subscriber through increased ability to maintain the system.

(a) Antennae

Antenna arrays, which are susceptible to both wind and ice loading, need to be rugged to provide long-term reliability. Attention should be given to protection of these arrays because failures tend to occur under the worst weather conditions, when it is time-consuming and difficult to repair them.

[1] Upper-case letters indicate to which of the main subsections a provision applies; e.g., provisions beginning with capital A apply to construction, B to signal reception standards, etc.

[1] Observation: A copy of these standards may be obtained by writing to the Occupational Safety and Health Review Commission, 1825 K Street, N. W., Washington, D. C. 20006. They are also published at 29 C.F.R. 2200.1 - 2200.110.

Suggested Alternative Provision:

A.02 Antenna shall be constructed so as to be able to withstand 70 MPH winds when there is one inch of radial ice on such antennae or 100 MPH winds with no ice. All feedpoints of such antennae shall be weatherproofed.[1]

Antennae should also be protected against corrosion in atmospheres subject to salt spray or severe industrial pollutants. Cable systems operating in communities located near the ocean or systems in communities containing areas where particularly high sulphur emissions are recorded may want to include a provision such as the following to ensure adequate protection of the system antennae.

Suggested Alternative Provision: Special Circumstances—Corrosive Atmosphere

A.02 Antennae shall be constructed so as to be able to withstand 70 MPH winds when there is one inch of radial ice on such antennae or 100 MPH winds with no ice. All exposed metallic parts of antennae shall be protected against corrosion. The feedpoints of such antennae shall be weatherproofed.

It is also desirable for all cable systems to install a high gain, broadband antenna that can be used as a temporary replacement for any damaged antenna. This search antenna can also be utilized in comparing the performance of other operable antennae. The following provision should ensure that such an antenna is available.

Suggested Provision:

A.03 A broadband log periodic antenna of ruggedized construction with an industrial, heavy duty rotor shall be mounted at the highest available location on the tower.

(b) Grounding

Grounding is necessary in cable systems not only for safety reasons but also because it can increase reliability and performance. Poor electrical grounding can, in the event of accidents, cause severe electrical shock. By providing proper grounding, the effects of lightning, electrical power surges, traffic noise, and interference to electronic components are minimized.

Suggested Provision:

A.04 The neutral side of the power drop shall be continuous and unfused. Where not in conflict with pole joint use agreements, all interconnection between the cable system ground and the power company ground shall be made at the base of the pole. Otherwise, the neutral line shall be bonded to the cutout cabinet, which in turn shall be grounded to a driven earth ground at the pole. The strand shall be bonded to the telephone strand at the first, the last, and at every fifth pole counting from the first poles. All cabinets, housings, and fused cutout cabinets on a common pole shall be commonly bonded to each

[1] This provision and the one immediately following it are numbered identically since only one of the two should be adopted by the franchising authority.

other and to the cable system and telephone strands with a pressure bonding and grounding clamp connected to five-eighths (5/8) inch by six (6) foot copper-clad steel ground rod with no. six (#6) solid, soft drawn copper wire. Anchor attachment shall be effectively grounded and electrically continuous to earth through the anchor. A guy bond clamp shall be inserted in all bolt and nut thimbleyes and at anchor guyed poles, if such poles are the last in any line of poles. If the strand at such locations (deadends) is not effectively earth-grounded, it shall be grounded by a length of no. six (#6) solid bare copper wire bonded to the messenger with strand ground clamps and subsequently bonded to a ground rod driven into a suitable earth ground. All aerial amplifier housings will be bonded to both the cable system strand and the telephone company strand using no. six (#6) soft-drawn copper wire with jacket and bonding clamps.

(c) Installation Specifications

A cable system is installed either aerially (strung on utility poles) or underground (buried directly or in conduits). Because of the high cost of constructing cable facilities, it is axiomatic that modifications involving these facilities will be made slowly or reluctantly after initial installation. For this reason, initial and/or rebuilt specifications to assure system reliability should be clearly specified within the ordinance. This section will examine some important reliability specifications with regard to aerial installation, underground installation, and to the coaxial cable itself.

(i) Aerial

In addition to the specific components involved in the aerial construction of a cable system, the overall installation must comply with existing local ordinances. This is shown below.

Suggested Provision:

A.05 Each cable distribution system in the public streets shall comply with all applicable laws and ordinance and governmental regulations regarding clearances above ground. (Refer to Section A.14).

(aa) STRAND

The trunk and feeder cables used in an aerial cable system are supported between adjacent utility poles by an additional cable commonly called the strand or messenger cable. This permits the tensions involved in the stringing of cable to be absorbed by the strand as opposed to the trunk or feeder cables.

In many cable systems, the strand used to support the trunk and/or distribution cables is one-quarter inch or smaller. In the last few years, larger diameter trunk cables have been used, and there is an increased likelihood of additional cables being installed (either during initial construction or in the future) to accommodate the many cable services being proposed. To prevent the need for replacement of the strand cables when additional trunk or distribution cables are installed, the franchising authority might request the use of even stronger strand than specified in National Bureau of Standards *Handbook #81* Sections 251 and 261. The example below is a method to obtain this type of construction.

Suggested Provision:

A.06 The strand or messenger cable used throughout for trunk shall be one-quarter (¼) inch in diameter or larger, high strength, seven-wire, preformed with galvanized zinc coating A.

In addition, the strand should be installed on the same side of the poles as the telephone facilities. This expedites future pole replacements, which is beneficial to the cable system operator. The example below represents a method of securing the proper positioning of the strand.

Suggested Provision:

A.07 All strand shall be installed on the same side of the pole as the existing utility facilities.

(bb) LASHING

The procedure by which the trunk or feeder cables and strand cables are connected together is referred to as lashing. The proper use of wire to lash these cables together during installation will not only provide a more attractive system but will minimize the occurrence of sections of cable being poorly supported and, in turn, having insufficient clearance.

Suggested Provision:

A.08 Stainless steel lashing wire, 0.045 inch in diameter shall be used in securing cable to supporting strand. Tension on this lashing wire shall vary according to the size of the cable being secured. Cable extending over long spans and steep grades shall be doubly-lashed. The lashing wire shall terminate at each side of the pole with a lashing wire clamp. The cables shall be fastened to the strand at each side of the pole with a lashed cable support. The support should be a maximum of ten (10) inches from the suspension clamp bolt.

(cc) HOUSING FOR ELECTRONIC EQUIPMENT

The major electronic components of the cable system (amplifiers, power supplies, etc.) should be housed in metallic boxes to protect the devices against adverse weather conditions.

Suggested Alternative Provision:

A.09 All electronic equipment shall be protected by weatherproof housing.

In those areas where corrosion from either salt spray or industrial pollutants is severe, the equipment housings should have additional protection.

Suggested Alternative Provision: Special Circumstances—Corrosive Atmosphere

A.09 All electronic equipment shall be protected by a housing which is corrosion-resistant and weatherproofed.

Future service will be improved if outages (defined as the subscriber receiving no signals from the cable system) and other equipment failures can be corrected rapidly. To help ensure this, equipment should be installed initially in such a fashion so as to be readily accessible for maintenance. Ill-planned selection of amplifier location can make rapid repair impossible.

Suggested Provision:

A.10 All electronic equipment shall be installed so as to be readily accessible for maintenance. Power supply locations shall be provided with self-healing arresters and fused cutout cabinets.

(dd) CONNECTORS AND SPLICES

The physical and electrical "mating" of cable and electronic equipment is performed through the use of equipment called connectors. These devices along with terminators (which are used to prevent reflections and to seal the ends of open cable) and splices (which are used to join sections of cable together) also affect the reliability and two-way performance of cable systems. As was the case with other items exposed to the elements, weatherproofing should be specified in the ordinance.

Suggested Alternative Provision:

A.11 All exposed splices, connectors, and terminators shall be waterproofed. All equipment connectors shall contain "O-rings" on the cable side of the connection.

Where corrosion is a factor, the following provision should be utilized.

Suggested Alternative Provision: Special Circumstances—Corrosive Atmosphere

A.11 All exposed splices, connectors, and terminators shall be waterproofed. Exposed connectors shall be corrosion resistant. All equipment connectors shall contain "O-rings" on the cable side of the connection.

Additionally, the franchising authority will want to guarantee that contraction of the cable during cold weather does not cause outages and other interruption of service. The measures contained in the following provision should help control the outages due to contraction.

Suggested Provision:

A.12 All equipment connectors and all cable splices shall be of seized center conductor type. All equipment entries shall be provided with expansion bands consistent with the bending radius of the type cable used. Splices shall have an expansion joint of at least eight (8) inches and be in a horizontal position.

The trunk line of a cable distribution system must be installed in a manner to optimize future reliability. Major sources of system outages can be traced to splices which are connections between sections of cable: thus it is desirable to keep splices

at a minimum. To encourage a system operator to use a single section of cable between trunk locations and not to economize with many short pieces, the following provision is suggested.

Suggested Provision:

A.13 There shall be no more than two (2) splices per mile of trunk cable.

(ii) Underground Construction

(aa) COMPREHENSIVE PLANNING

Inherent in requiring underground cable construction are increased capital costs and increased maintenance problems. Because underground plant is difficult to repair and upgrade once construction has been completed, franchising authorities should carefully plan the ordinance provisions regarding underground construction so as to ensure that facilities do not rapidly become obsolete.

Suggested Provision:

A.14 Each cable distribution system required to go in or under the public rights of way including, without limitation, streets, sidewalks, alleys, and easements, shall comply with all applicable laws, ordinances, and governmental regulations.

(bb) USE OF CONDUITS

To increase reliability of the cable system, underground cables need protection from vibration and trenching, especially where they cross streets. The use of conduit of sufficient size provides this protection and permits adding supplemental cables in the future without tearing up the street again.

In order to assure that future cable can be installed in the conduits at a later time, a nylon line should be tied to the initial cable as it is pulled through the conduit. This simplifies pulling additional cables through the conduit in the future.

Suggested Provision:

A.15 Under paved areas and roadways, the cables shall be installed in conduit not less than two (2) inches in size. Cables pulled through conduits for more than twenty (20) feet shall include a fine nylon line or some other equivalent device. Such conduit, when constructed for the cable system, shall be zinc-coated steel or equivalent plastic. Conduit shall be extended not less than two (2) feet beyond pavements and roadways, when such roadway is utilized for vehicular traffic.

(cc) TRENCHING STANDARDS

In those areas where conduit is not required, it is necessary to protect the cable from weather and soil conditions and from man-made hazards.

Suggested Provision:

A.16 Trenches in which direct burial cables are placed shall have a minimum

depth of eighteen (18) inches below grade, and shall generally be in straight lines between cable connections except as otherwise necessary. Bends in trenches shall have a radius of not less than thirty-six (36) inches. Rock, where encountered, shall be removed to a depth of not less than three (3) inches below the cable depth and the space filled with sand or clean earth, free from particles that would be retained on a one-quarter (¼) inch sieve.

(dd) HOUSING FOR ELECTRONIC EQUIPMENT

(See ordinance provision A.09 and accompanying textual material.)

(ee) CONNECTORS AND SPLICES

(See ordinance provision A.10 and accompanying textual material.)

(iii) Cable

The use of 75 ohm coaxial cable, amplifiers, and passive devices has become standardized within the cable industry. Therefore, to minimize the introduction of interference by nonstandard cable which may be used for some kinds of future cable services, the requirements suggested in the provision below would be helpful.

Suggested Provision:

A.17 All coaxial cables used in the system shall have a nominal characteristic impedance of seventy-five (75) ohns over the entire frequency range to be utilized.

Both trunk and feeder cable can be used for either "upstream" (subscriber to headend) or "downstream" (headend to subscriber) delivery of signals. In many cases these cables will be the same size. Therefore, it is necessary that each of these cables be identifiable according to its function to assure efficient cable service. Moreover, identification of each cable's route is important because it facilitates timely repair.

Suggested Provision:

A.18 Cable of the same size being used for different purposes and lashed together shall be clearly identified as to its function. All main trunk and feeder cables shall be clearly identified at the output of each equipment location indicating each cable's route.

Many coaxial cables have an outer shield of aluminum that is susceptible to corrosion. For aerial installation in areas where corrosion is a factor, the following is recommended.

Suggested Provision: Special Circumstances—Corrosive Atmosphere

A.19 Trunk and feeder cable shall have a protective jacket covering the outer conductor.

For underground installation, two protective approaches are recommended. The

first should be used when the cable is buried directly in the ground, while the second applies to cable installed in conduits. For the same system, both provisions may be applicable.

It should be noted that the protective steel covering will prevent breakage from gardener's shovels but will not be effective against various utility power digging devices.

Suggested Provision: Special Circumstances—Corrosive Soil

A.20 No trunk or distribution cable shall be directly buried unless it contains a protective steel outer covering (spiral wrap or corrugated), a second polyethylene jacket protecting the steel from corrosion, and a moisture barrier flooding compound inside both the inner and outer jackets.

Suggested Provision:

A.21 No trunk or distribution cable shall be installed in conduits or ducts (tunnels and manholes) unless it contains an outer polyethylene jacket, plus a moisture barrier flooding compound.

Construction standards inevitably become a source of controversy. There will be those who say that the imposition of construction standards upon a young industry will retard its growth; that such standards will arbitrarily increase the cost of construction and that market forces will enforce adequate construction practices.

In one sense, the last argument has merit. Responsible system operators adopt these construction standards as a matter of good industry practice. If this were universally the case, there would be no need for standards. However, it is possible to save on construction costs by taking construction short cuts. Some operators may be tempted to do so and argue that these standards amount to "gold plating."

The franchising authority should consider that the cable industry has dramatized its potential for public services, especially in the future, and failure to adhere to good construction practices, while saving money in the short run, may in the long run retard the development of more sophisticated services.

B. SIGNAL RECEPTION STANDARDS

Cable television systems may meet very high performance standards yet still deliver low quality pictures to subscribers. Broadcast television signals carried on the cable can be poor because the headend antenna is badly situated, poorly designed, badly installed, or because the television station broadcasting the signal is defective.

From the subscriber's viewpoint, poor service is poor service, regardless of the cause. The franchising authority, however, must be capable of pinpointing responsibility for poor performance. Standards for reception of broadcast signals define for a system operator the minimum quality of the signal the system must secure with its antenna before it distributes the signal to subscribers. These standards also provide a

way of grading the quality of each "locally receivable signal,"[1] against which the performance of the system in delivering that signal to subscribers can be measured. While standards would be desirable for distant signals, the wide variety of reception problems precludes setting such standards. (See page 22 and following.)

Off-air signal quality will be largely determined by the antenna site location, sources of nearby power, industrial or ignition noise, the height of the tower (for distant signals), and the design of the antenna arrays (to minimize co-channel interference). To ensure high quality off-air signals, a signal survey should be conducted by a qualified engineer.

The factors to be measured by the signal survey are noise, hum modulation, beat interference, reflections, signal level, and color quality. To eliminate distortions it is desirable to isolate the sources of these distortions and determine whether they originate from the transmitted signal, the propagation to the antenna site, or the antenna array. Often, cable operators are unjustly blamed for poor reception on a local channel which is in fact the result of a defective transmitted signal. On the other hand, improper placement of antennae or the close proximity of tower braces can degrade signals, resulting in poor color or causing ghosts.

Suggested Provision:

B.01 Each company shall conduct an on-site signal survey before application is made to the Federal Communications Commission for a certification of compliance to determine optimum selection of tower and antenna locations and shall provide the results and information therefrom as delineated in E.01(b) of this Ordinance.

The quality of pictures delivered to any subscriber can be no better than those received off-air. The first step toward assuring the reception of good pictures is the measurement and analysis of any distortions before such signals are processed by any electronic equipment. For this reason, signal quality standards are provided. (Procedures for measurement of these signals' quality are suggested in Appendix A.)

1. Off-Air Signal Quality

To ensure that the received signals are not degraded in quality, the technical standards outlined below represent minimum off-air requirements for locally receivable signals. There are many important factors to consider in determining the quality of reception of a television signal. The following five factors can be measured without great difficulty, so standards are recommended. These are:

- signal levels of video and audio carrier
- video signal to RMS noise
- signal to hum modulation
- signal to echo
- luminance to chrominance amplitude.

[1] The term "locally receivable signal" is defined as a signal from a station whose grade A contour includes either a majority of the franchise area or includes the cable system signal reception site. A grade A contour is an FCC field intensity contour. (47 C.F.R. 73-683)

Please note that this definition should be included in a franchising authority's ordinance. Also, this definition precludes the setting of standards for some signals that may be received off-air by some viewers in a franchising area. However, few signals which can be carried on a cable system under the FCC signal carriage rules are exempted (see generally 47 C.F.R. 76.51 et. seq. on "Carriage of Television Broadcast Signals").

Development of standards for off-air signals is relatively meaningless unless a means is developed for permanently recording results of the tests used to measure the distortions listed above. For example, measurement of signal levels of incoming channels provides information concerning the relative power level of the video and audio carriers, the expected picture quality, and predicted fading. No reception standards are set for the signal levels of the video and audio carrier levels. For the remaining factors, standards can and have been provided. A specific discussion regarding the development and maintenance of performance records is contained in Section E. However, the following suggested provision should be included in the ordinance.

Suggested Provision:

B.02 Measurement of signal video and audio carrier levels, signal to noise, signal to hum modulation, signal to echo, and off-air luminance to chrominance amplitude response shall be taken and recorded for each locally receivable signal. These measurements shall be taken at times specified in Subsection D of this Ordinance.

(a) Video Signal to Noise Ratio

The video signal to RMS noise test measures the relationship of the signal to the sum of power line, industrial, cosmic, thermal, and ignition noises (or interference).[1] This measurement should be made during normal reception times; therefore, the test must involve measuring the noise content of the signal itself while being transmitted. Care must be taken to exclude measurements taken when the station is transmitting "noisy" video tapes or films.

Since the FCC has not issued off-air signal quality standards, the following suggested ordinance provision can be used.

Suggested Provision:

B.03 Locally receivable signals shall be received with a video signal to RMS noise ratio of no less than forty (40) dB.[2]

(b) Signal to Hum Modulation

Hum modulation of an off-air signal produces horizontal bars in the television picture and usually results from power supply ripple modulating the signal. Because the off-air signal has gone through no other electronic equipment after leaving the transmitter—and if the test equipment is not at fault—the modulation is likely originating in the film, videotape, or transmitting equipment and there is little the cable operator can do other than notify the TV station.

The examples below suggest a means for securing a basis of comparison between the hum modulation on the incoming signal and the amount to be measured later at the furthest points of the system.

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[1] The video signal, excluding synchronizing pulses, is related for test purposes to the voltage between black and white levels. RMS noise is quasi peak-to-peak noise (as measured on an oscilloscope) reduced by 14 dB. These standards are for color; for monochrome they could be 2 dB less.

[2] This is equivalent to an RF signal to noise ratio of 43 dB at 4 MHz.

Suggested Provision:

B.04 The ratio of off-air signal to hum modulation shall be measured and recorded for each locally receivable signal. Such measurements must show any signal degradation beyond the system standard of five (5) per cent (-26 dB) as specified in 47 C.F.R. 76.605(a)(7).

(c) Signal to Echo

For purposes of this standard, echoes, which are ghosts or double images, are limited to those having sufficient time delay to be observed and measured as a separate signal with a time displacement of one microsecond or more. They appear as single or multiple reflections of the original signal on the television viewing screen. A standard signal to reflection ratio of 34 dB or better is desired; unfortunately, this standard is difficult to meet in many urban areas where the walls and roofs of buildings act as multiple reflectors. The system should use highly directive antennae and take advantage of any shielding from undesired signals by penthouses or elevator shafts; but in many cases, it may still only be able to reach 28 dB.

Illustrated below is a method for setting a standard of performance for the echoes on each local channel whether they originate from the station transmitter, terrain reflection sources, antenna array, or propagation conditions.

Suggested Provision:

B.05 The signal to echo ratio for locally receivable signals should be at least 34 dB for echo(es) that are displaced by one (1) microsecond or more. In those cases where thirty-four (34) dB is not feasible, a full explanation of the reasons for the failure to meet this standard shall be included in the report required under E.01(b). Approval of the City must be received as an exception to this provision for any locally receivable signals having a signal to echo ratio of less than twenty-eight (28) dB for echo(es) that are displaced by one (1) microsecond or more.

(d) Luminance vs. Chrominance Amplitude Response

A color television picture is composed of a black and white signal that determines the brightness and contrast, and of color signals that determine the color (chroma) intensity and hue. These signals are combined to form the composite color television signal that has energy in the low frequency video band (referred to as luminance) and in the higher frequency video band (referred to as chrominance). Variations in the relative amplitudes of luminance and chrominance will cause changes in relative color saturation of the picture.

The luminance to chrominance ratio is affected by propagation of signals through the air and antenna array response. High gain single channel antennae, when stacked in a field of structural steel, can lose bandwidth and degrade high frequency response. Comparison should be made between the broadband search antenna and the respective multiple array.

The reduction of energy at the color subcarrier frequency (3.58MHz) usually signals a loss of high frequency definition in the television picture. Therefore, this is an important criterion which has not been specified as yet by the FCC and should be

subject to municipal regulation. A possible method of requesting standards for chrominance amplitude is illustrated below.

Suggested Provision:

B.06 The ratio of the amplitude of the horizontal sync pulse to peak color burst for locally receivable signals shall be no greater than two (2) dB.

2. Microwave Signals

There are two special considerations involved in the transmission of television signals by microwave. One is the problem of microwave system reliability, the other is microwave system performance. Both matters are complicated by the fact that the microwave system may not be owned or controlled by the cable system operator.

(a) Microwave Reliability

Outages in microwave service can occur because of signal fading and intense rainfall (as well, of course, as equipment failures). Proper design and layout of the microwave system reduces such outages and thus improves reliability. Reliability design specifications are expressed in terms of per cent reliability, or maximum number of hours of system outage permitted per year.

A desired yearly reliability would be that the system remain operational 99.99 per cent of the time. This would be the equivalent of about one hour of outage per year. Such a standard is, however, impractical because it raises capital and operating costs excessively. An acceptable compromise is to have the system remain operational 99.9 per cent of the time, thus permitting a maximum of nine hours of outage per year.

If the system contracts for microwave service, it should require in the contract that the reliability standard be met by the microwave service. The suggested provision below covers both circumstances.

Suggested Provision:

B.07(a) Where microwave is utilized for distant signal reception, the total microwave path, whether single or multiple microwave hops, shall have a design reliability of no less than 99.9 per cent, or no greater than nine hours of picture outages per year.

(b) Microwave Picture Quality[1]

The amount of picture quality distortion introduced by a microwave system is generally quite small. But the amount of distortion introduced is normally beyond the immediate control of the cable system operator. For example, the greater the distance between an imported signal's origination point and the cable system's tower, the greater the chance of interference being introduced due to the high number of microwave hops. Additionally, in many instances, private corporations own and operate the microwave relay stations used for importing distant signals. In

[1] Note that although no substantive standards are established here, explanation of the provisions that have been made to ensure the high quality of the imported distant signal is required.

these cases, the cable system operator's only control over the transmission system is in the tariffs and/or contracts signed with the transmission system.

For these reasons, it is not feasible to set standards for distant signal importation. However, it is appropriate to measure and record the five factors of signal quality discussed earlier. To provide a record of the signal quality actually achieved, the following provision is suggested:

Suggested Provision:

B.07(b) Measurement of signal levels of video and audio carrier, signal to noise, signal to hum modulation, signal to echo, and the luminance to chrominance amplitude response delivered to the headend equipment shall be taken and recorded for all distant signals carried on the cable system.

3. Cablecasting and Local Origination

The FCC's technical standards apply to the performance of a cable television system and to each of the Class I cable television channels in the system. In accordance with the desire to encourage use of local origination and access channels, the commission has refrained from issuing standards for these services. For the same reasons, the center recommends that the franchising authority not issue, at the present time, performance standards for Class II, III, and IV signals. (See Section 1 of "How to Plan an Ordinance" - Definitions.)

It is, however, realistic to assume that a system constructed to meet high performance standards for delivery of television broadcast signals would be likely to deliver quality cablecast signals as well—assuming that the signals produced by the cablecasting equipment have reasonable initial quality. Thus, rather than specify standards for non-broadcast signals, the suggested ordinance discussed in the next section should serve until there has been sufficient experimentation upon which to predicate realistic standards for such signals.

From the franchising authority's perspective, there is a clear trade-off involved in the determination of local origination standards. Signal quality is almost directly correlated with cost: the higher the investment in equipment, the higher the quality.[1] Similarly, the degree of expertise required to effectively utilize this equipment also varies directly with the cost of the equipment. By requiring high standards of signal reception, the franchising authority may inadvertently limit the degree to which local programming grows and flourishes.

On the other hand, by setting no standards and encouraging the use of low cost, low quality video equipment, it is possible that while experimentation is being encouraged, subscribers will not view these experimental programs because of signal quality that compares poorly with broadcast signal quality.

Although no technical standards are established and there is not an equipment requirement, the cable system operator must describe origination equipment and the quality of pictures expected from its use. See E.01(b).

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[1] Local origination facilities must be designed to meet the needs of the communities they serve. The range of studio options is so broad that facilities can be designed only after the franchising authority has weighed its planned uses against capital costs.

Decisions should be made by the franchising authority pertaining to the quality and quantity of the local origination services, i.e., whether it shall be color or black and white, whether provided by a single remote portable camera and cassette or by complete facilities at specific locations.

C. SUBSCRIBER VIEWING STANDARDS

The FCC has only set cable television technical standards for the delivery of broadcast television signals by a cable system. The commission expects soon to develop technical standards for cablecast programs, and ultimately, two-way communications.

In the meantime, effective performance standards for broadcast television signal carriage is the most appropriate means for assuring that the cable system is capable of doing what it was designed to do.

One method of defining subscriber performance standards is to specify exactly how each component of the cable system will perform, and require the system operator to install the specified equipment. This is an unsatisfactory approach because it does not guarantee overall performance of the system.

A more effective approach is to require the system to deliver a specified quality of signal to subscribers, without specifying how it should do so. The franchising authority can require that for a specified grade of signal received at the cable system headend, the system must deliver a specific standard of signal quality to subscriber. Since standards for the acquisition of broadcast signals have already been defined, ordinance provisions for signal delivery standards should be developed to complete performance standards.

The standards discussed in this section of the supplement are based upon both existing FCC regulations and standards developed by the center in the absence of an FCC rule making.

1. Overall System Signal Standards

The FCC has established minimal standards covering the performance of the system in delivering signals from the headend to the subscriber, and the provisions below suggest a means of securing compliance. Please note that two-way services will likely require performance standards in the future, but until further knowledge is available about these services, it is premature to set specific standards.

Suggested Provision:

C.01(a) The Company shall comply fully with the rules and standards for cable television operations as adopted by the Federal Communications Commission. 47 C.F.R. 76.601-76. 613 (1972).

C.01(b) The Company shall comply fully with the rules and regulations contained and promulgated within this Ordinance. Where conflict occurs between the provisions herein contained and those of the FCC, the more restrictive shall apply to said Company.

These overall standards neither provide protection nor ensure against excessive signal degradation due to factors such as differential gain and phase and envelope delay. To guard against undue degradation caused by these factors, without setting specific standards at this time, the following provisions should be included in the ordinance.

Suggested Provision:

C.02(a) The cable system shall be capable of delivering all National Television

Systems Committee (NTSC)[1] color and monochrome standard signals—developed and presented to the Federal Communications Commission on July 21, 1953—to standard Electronic Industries Association approved television receivers without noticeable degradation.

C.02(b) The system shall be capable of delivering all signals meeting the FM transmission standards of the Federal Communications Commission to Electronic Industries Association approved stereophonic or monaural FM receivers.

2. Long-Term System Signal Standards

Another provision that should be included in the ordinance provides that standards be met at average temperatures prevailing in the area—not only at 70 degrees F, which is usually set as a design reference. It is not necessary that these standards be met at exceptional temperature extremes, although the system must remain operational at those extremes. Below is a provision specifying this temperature requirement which employs as a reference the climatic maps of the United States as prepared by the U.S. Department of Commerce.

Suggested Provision:

C.03 The cable system shall meet all performance criteria herein contained and specified over the ambient temperature range prevailing in the franchise area from the normal daily minimum temperature in February to the normal daily maximum temperature in August.

3. Specific System Signal Delivery Standards

The FCC specifies standards for some characteristics of a delivered television signal. However, the commission's standards do not guarantee that a subscriber's television picture will have no visible degradation. The standards outlined in this section are more comprehensive and stringent, and, if enforced, will result in the best picture quality obtainable with present technology.

The present FCC rules do not adequately cover signal degradation resulting from echoes within the system.

Echoes (or ghosts), for purposes of this standard, are limited to those originating anywhere between the headend and subscriber location, having sufficient time delay to be observed and measured as separate signals with a time displacement of one micro-second or more.

A standard should be developed which prevents the appearance of echoes that originate either in the system or within the subscriber's receiver as caused by "direct pickup" of a local television station. Direct pickup results when the undesired signal is received directly by the drop cable or an unshielded lead from the back of the TV receiver to the tuner. This signal arrives before the desired one via the cable system, causing a leading echo.

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[1] The National Telcvision Systems Committee (NTSC) was created by the FCC in 1951 to determine the optimum system and standards for color television so that color rendition would be satisfactory and the ultimate system would be compatible with black and white standards. A report encompassing the recommendations of its various panels was submitted to the FCC in 1953 and became the basis for present standards.

Commercial television and FM receivers are designed to comply with the standards of the Electronic Industries Association.

The following standard goes beyond present FCC regulations and should therefore be included with those promulgated by the community. This approach ensures that the system's cable and equipment do not introduce ghosts.

Suggested Provision:

C.04 Except where the off-air signal meets a lower standard, echoes measured at system extremities or at subscriber locations, with displacement of one (1) micro-second or more, shall not be less than thirty-four (34) dB; should the off-air grade at the antennae be twenty-eight (28) dB, the echo rating may also be twenty-eight dB or higher. The overall echo rating for a locally receivable signal shall not be less than twenty-eight (28) dB unless a lower off-air standard has been accepted for this signal by the City.

An overall standard is needed to measure the quality of the color on the various channels since it is possible for defective cable or system components to introduce a response loss at the color subcarrier frequency (3.58 MHz) of a channel. This would reduce the amplitude of the 3.58 MHz energy, resulting in noisy color TV pictures. A means of measuring this standard is based upon the relative amplitude response of the low frequency video information (luminance) as compared to the higher frequency color information (chrominance). The horizontal sync pulse can be used as a reference for luminance and the peak-to-peak amplitude of the color burst (ignoring displacement) can be used for chrominance since their relative transmitted level relationship is within one dB. Another advantage is that this measurement can be made without interrupting service. The FCC as yet has not addressed itself to this standard. But, since it is important because of both color quality and high frequency definition of a TV picture, the franchising authority should shoulder this responsibility.

The suggested standard covers a signal degradation as introduced from off-air signals, headend and system variations.

Suggested Provision:

C.05 The ratio of horizontal sync pulse amplitude to the peak-to-peak 3.58 MHz color burst amplitude of the same locally receivable channel shall meet a standard of not greater than two (2) dB as measured at system extremities.

There is a need for an overall standard for signal to noise—more restrictive than the FCC's regulations—that includes degradation due to the incoming locally receivable signal. It is important to ensure that local channels delivered through the cable system are equal or better in quality than those received off-air on home antennae.

Suggested Provision:

C.06 "Locally receivable" signals shall be delivered to subscribers with a video signal to RMS noise ratio of no less than thirty-seven (37) dB.[1]

[1] A video signal to RMS noise ratio of 37 dB is equivalent to an RF signal to noise ratio at 4 MHz bandwidth of 40 dB. To meet this overall subscriber standard of 40 dB where a locally receivable grade A television channel is received off-air at the minimum of 43 dB (see B.02 in this ordinance), the transportation and distribution part of the cable system must meet a standard of 43 dB.

There is also need for an overall standard for signal to intermodulation by discrete frequencies of interference. Since this type of interference can be objectionable even at low levels, the following standard is suggested.

Suggested Provision:

C.07 The ratio of visual signal level to the RMS amplitude of any coherent disturbances including, without limitation, intermodulation products or discrete-frequency interfering signals not operating on proper offset assignments, shall not be less than fifty-two (52) dB as measured at any subscriber terminal for each Class I cable television channel in the system.

With the advent of 30 channel cable systems using the low and high VHF spectrums plus the midband and superband spectrums,[1] another form of intermodulation is introduced which results from an accumulation of triple beats due to the interaction of the multiplicity of signal carriers. For example, in a 30 channel system there will be more than 100 interfering signals within the frequency spectrum of channel 7; these interferences appear on the television screen somewhat like background noise.

Suggested Provision: Special Circumstances

C.08 A cable system delivering more than twenty (20) channels to subscribers and using the midband and superband channels along with the standard VHF bands to do so, shall have a ratio of the thirty (30) channel type triple beat interference of no less than forty-six (46) dB.

D. PROOF OF PERFORMANCE—TESTING

The franchising authority should set forth reasonable and effective procedures to test the ability of the cable system to meet prescribed technical standards. The choice of testing programs depends upon local circumstances. The more exhaustive and frequent the tests, the more likely the system will deliver quality service to subscribers. However, frequent and thorough testing is expensive. Under the terms of the franchise, the cost of testing is likely to be borne by the system operator. Hence, the testing program should strike a reasonable balance between the franchising authority's need for proof and the system operator's desire to avoid an unwanted financial burden.

In this section, provisions are developed for four kinds of system tests.

— As a condition of the franchise agreement, the franchising authority might require an *initial*, exhaustive, proof of performance demonstration of system technical performance within 60 days of the provision of service. In each case, the purpose of the tests would be to build a sound "portrait" of the system's capability for the franchising authority.

— Many performance tests involve interruption of service. Once service has begun, tests which interrupt service should be conducted only as often as is necessary to ensure that performance standards are maintained. The FCC requires *annual* tests.

[1] Midband spectrum is between 108 and 174 MHz, whereas superband spectrum is that above 216 MHz and up to 300 MHz.

The franchising authority may wish to have the system tested for its standards at the same time.

— In addition, the franchising authority may require a series of inexpensive *monthly* tests that do not require disabling the system. Initial and annual tests can be anticipated by the operator. Judicious preparation for these tests may undermine their value as measures of system performance, and may possibly make test results misleading and ambiguous. An effective testing program should result in high quality system performance at all times. The administration of monthly tests, conducted by the system operator and reported to the franchising authority, provides a mechanism to ensure that the system performs at a consistently high level.

— Finally, the franchising authority may reserve the right to request that *special* tests be conducted by the operator. Such special tests could be requested by the franchising authority when it has responsible evidence that something is wrong with the system.

In the sections that follow, initial, annual, and monthly test provisions are analyzed in terms of test costs for small and large systems.

Provisions relating to the form and manner of keeping the results of these tests is discussed in detail in Subsection E—Proof of Performance—Records.

1. Initial Testing

Although the FCC does not require an initial proof of performance test, the initial test may be the most important of all to the franchising authority. The initial test establishes what the system is capable of doing just after the system operator begins regular service, at a time when corrective action is most easily taken.

The tests outlined below involve the services of an independent engineer, selected jointly by the city and the system operator. Test costs presume the services of a registered professional engineer, in order to illustrate the highest test costs. They should not be taken as an indication that the center advocates restriction of test contracts to a particular licensed group. What is most important is a competent and independent source of advice.

The tests also involve the services of the system engineer or technician, and an installer. The manpower requirements for the test are estimated 25 miles of plant to be:

Estimated Manpower Requirements:
Initial Proof of Performance Test

	Prof. Engr.	System Engr.	Installer
CTIC Test	7 man days	6 man days	6 man days

Plus: ½ man days each for each additional 50 miles of plant.

Labor costs vary widely, but for the sake of illustration if labor costs were:

Professional Engineer	$300/day
System Engineer	$ 75/day
System Installer	$ 25/day

and assuming both a small system (25 miles of plant, 1,500 subscribers) and a large system (250 miles of plant, 15,000 subscribers), then test costs would amount to:

Estimated Initial Proof of Performance Test Costs

	Total Cost	Cost/Subscriber/Year
Small System	$2,700	$1.80
Large System	$3,600	$ .24

Testing costs are clearly proportionately heavier for the small system operator, although not overwhelming. The major cost component is the fee for the registered professional engineer. In order to save costs—for example, for a very small system—the franchising authority may wish to relax this requirement.

If the franchising authority adopts initial tests, the concept of the initial performance testing should be set forth with a general provision outlining the test plan.

Suggested Provision:

D.01 Performance requirements and standards specified in this document, and in all FCC requirements and standards, shall be measured at the time of initial testing as provided in Section D.02 of this Ordinance, to ensure compliance with such previously specified requirements and standards for construction, off-air reception, and subscriber viewing as specified in Subsections A, B, and C of this Ordinance. Measurements shall be taken and recorded at test locations specified in Section D.02(b). Costs of such tests shall be borne by the Company.

Three basic questions must be resolved within any regulatory ordinance before proof of performance testing has any real effect. The ordinance should specify:

- when and where testing should take place
- what types of equipment should be used in the tests, and
- how the tests should be made.

Much of the performance of a cable system is essentially statistical in nature with respect to both time and location. Sampling procedures with regard to both time and place are therefore necessary. The FCC requires that systems be tested once a year at three sample points; for large systems, the FCC's program may be inadequate. Presumably, the operator could adjust the system prior to the tests, and could select the three locations that would be most likely to pass. This provides very little assurance that other subscribers at other times are receiving proper service.

Initial testing should occur with the completion of construction of each section of the system and should be tied to the construction timetable established by the franchising authority. (See also 47 C.F.R. 76.31(a)(2).) Although it is quite difficult to accomplish, every attempt should be made to specify that initial testing should occur at a time shortly after the completion of each of the various stages of system construction. A procedure for specifying when and where initial testing should occur is illustrated below. The suggested provision assumes a construction timetable which has divided the franchise area into definite regions for construction purposes.

Suggested Provision:

D.02(a) Initial proof of performance testing shall occur within sixty (60) days of the commencement of cable service to each section of the system franchise area as delineated in the construction timetable of Section___of this docu-

ment with area____being constructed and tested first, and areas____,____,____ and____being constructed next in the order specified in the aforesaid construction timetable. Initial proof of performance shall also be tested within thirty (30) days of the commencement of cable service to new subscribers on any extension of the system to areas within the jurisdiction of the City but not specified in the construction timetable, and within thirty (30) days after service has been extended to new subscribers upon any reconstruction of the cable system.

D.02(b)i The number of test locations for initial proof of performance testing shall be as follows: a minimum of three (3) trunks, three (3) line extenders and twenty-five (25) multitap locations where there is less than twenty-five (25) miles of activated cable plant. For every additional fifty (50) miles of cable plant there shall be an additional trunk, an additional line extender and five (5) additional multitap locations.

D.02(b)ii The locations of the test points for initial proof of performance testing shall be as follows: at the last trunk amplifier in widely separated points in the system at least one of which is representative of terminals most distant from the system as chosen at random by the company, such feeders not being fed directly by the above mentioned trunk amplifier locations; and at multitap locations as selected at random by the company to provide coverage of the entire area.

D.02(b)iii Should performance at any of the trunk locations prove defective, the system shall be appropriately corrected and another proof of performance test shall be scheduled; should performance at any line extender prove defective, additional feeders shall be selected at random and tested until such time as five (5) consecutive feeders can be tested and found acceptable; should signal levels at more than ten (10) per cent of the multitap locations not meet specifications, the system shall be appropriately corrected and proof of performance shall be scheduled for a later date.

An important aspect of the evaluation of system performance is consideration of the picture reception levels and the signal levels. However, to require such measurements would not only pose an undue economic burden on the operator, but might also delay system connections required to commence actual service over the cable. Ideally, one would like to be in the position of requiring measurement of signal levels at each subscriber location. However, fewer tests permit the use of better equipment by more competent personnel.

The accuracy and sensitivity of the instruments used influence the reliability of test measurements. Hence, some specification of test equipment is necessary, especially since some of the standards in this document exceed the FCC's current rules. One method of specifying test equipment is illustrated in the provision below.

Suggested Provision:

D.03 All measurements shall be made using instruments which are each appropriate for making each particular test. Such instruments, whose accuracy can be ultimately referenced to those standards developed by the National Bureau of Standards for test equipment, shall each have the accuracy sufficiently sensitive to measure each parameter. Such test equipment and instruments shall have a known correction factor for bandwidth and scale position where applicable.

For those tests required by the FCC, the guidelines for various methods of measurement provided by the commission should be employed. The provision below ensures that these procedures will be adhered to.

Suggested Provision:

D.04 Tests and measurements to ensure compliance with technical standards shall be performed in a manner that is consistent with the provisions of 47 C.F.R. 76.609, et. seq. (1972).

Additional standards have been suggested both for off-air signals and for the overall system. Standards cannot be realistic without having available initial proof of performance tests procedures that involve equipment costs that are accurate and reasonable. Included are suggested testing provisions developed by the Cable Television Information Center.[1] The provision below is one way of utilizing these suggested testing procedures.

Suggested Provision:

D.05(a) Until such time as the franchising authority designates other procedures, the testing procedures contained in Appendix A of this Ordinance—"Test and Measurement Procedures"—shall be utilized at the time of initial testing for measurements of off-air video signal to RMS noise, off-air signal to hum modulation, off-air signal to interfering signals, off-air signal to echo, off-air luminance vs. chrominance amplitude, system signal to echo, and system luminance vs. chrominance amplitude, unless the Company shall choose different test procedures.

D.05(b) In the event that the company should utilize any testing procedures that differ in any respect from those testing procedures specified in Appendix A of this Ordinance or those specified in 47 C.F.R. 76.601 et. seq. (1972), the procedures shall not be acceptable unless the report of said test is accompanied by the statement of an engineer or equivalent as provided for in D.06 of this ordinance. The statement of said engineer shall include assurances and warranties that the test procedures utilized were as accurate as those test procedures specified in Appendix A of this Ordinance and 47 C.F.R. 76.601 et. seq. (1972).

D.05(c) (To be used in a contract or franchise, but not in an ordinance.) The City reserves the right to amend this provision at a later date to provide for mandatory test procedures.

Except, perhaps, for very small systems—where costs may be prohibitive—it is suggested that an engineer or qualified technician, selected jointly by the franchising authority and the franchisee, conduct or supervise the tests.

Suggested Provision:

D.06 Initial testing shall be done under the supervision and direction of an engineer. Said engineer shall be selected jointly by the City and the Company. All records of initial tests shall be signed by the aforesaid engineer, who shall include in such records a statement of his or her qualifications.

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[1] There are other possible methods of measurement which will become even simpler and more automated in the future with the development of increasingly sophisticated test equipment and the testing procedures will also go in this direction—becoming simpler and more automated.

2. Annual Testing

The FCC requires cable system operators to conduct an annual test of system performance, and maintain records of tests for commission inspection. The FCC tests do not test adequately for CTIC performance standards, and it is suggested that the franchising authority require a separate annual proof of performance test, which should include all of the tests required in initial proof of performance except for the measurement of levels at multitaps. It is again recommended that an engineer selected jointly by the franchising authority and the operator, and paid for by the operator, supervise the annual tests. For very small systems this requirement may be waived.

The costs for the annual tests, if conducted with the FCC required test, would not be excessive. Manpower requirements for 25 miles of plant are estimated to be:

Estimated Annual Proof of Performance Test

	Prof. Engineer	System Engineer	Installer
FCC Tests	3½ man days	2½ man days	2½ man days
CTIC Tests	1½	1½	1½
Total	5	4	4

Plus: ¼ man day each for each additional 50 miles of plant.

Assuming the same labor costs as before, test costs would be:

Estimated Small System Annual Test Costs

	Total Cost	Cost/Subscriber/Year
FCC Test	$1,300	$ .87
CTIC Test	600	.40
Total	$1,900	$1.27

Estimated Large System Annual Test Costs

	Total Cost	Cost/Subscriber/Year
FCC Test	$1,300	$ .09
CTIC Test	1,050	.07
Total	$2,350	$ .16

Here too, test costs are proportionately more burdensome for the small operator, though not as "regressive" as the FCC's tests. Franchising authorities may wish to consider relief for very small systems, relying upon FCC tests alone.

Suggested Provision:

D.07(a) Performance requirements and standards specified in this document, including all FCC requirements and standards, 47 C.F.R. 76.601, et. seq.

(1972), and all local performance guidelines, shall be measured annually to ensure compliance with such previously specified standards for off-air reception and subscriber viewing as specified in Subsections B and C of this Ordinance. Measurements shall be taken and recorded at the test locations specified in section D.02(b), except that construction compliance and multitap testing is not required in the annual tests. The costs of such tests shall be borne by the Company.

D.07(b) All measurements for the annual testing shall be made with test equipment meeting standards set in D.03.

D.07(c) Annual testing shall be done under the supervision and direction of an engineer or equivalent as provided for in Section D.06. Said engineer shall be selected jointly by the City and the Company. All records of annual tests shall be signed by the aforesaid engineer, who shall include in such records a statement of his or her qualifications.

D.07(d) The testing procedures referred to in D.05(a) shall be used for annual testing. In the event that alternative testing procedures are utilized by the company such procedures shall be detailed and justified as provided in D.05(b).

D.07(e) (To be used in a contract or franchise agreement, but not in an ordinance.) The City reserves the right to amend the provision at a later date to provide for mandatory test procedures.

D.07(f) The aforesaid engineer shall render a report to the City as prescribed in Section E.02(b).

The franchising authority may wish to employ the engineer who conducts these tests to review the technical records furnished during the year by the system operator, including monthly test reports, reports of equipment changes, or others. Such an arrangement may compensate for the lack of technical expertise on the franchising authority's staff. It need not be stipulated in the ordinance.

3. Monthly Testing

To overcome the inherent limitations involved in annual system tests, it is recommended that monthly tests be considered by the franchising authority. These monthly tests would examine a few key characteristics of the cable system, but would not measure the quality of off-air signals. Moreover, these monthly tests would employ both objective and subjective test methods, neither of which would cause a disruption of service, nor require the services of a qualified engineer.

The franchising authority should consider carefully whether to impose monthly tests, and if so, whether the test team should include a representative of the city. The costs may be significant, as the tables below indicate.

Manpower requirements for the monthly test (assuming 25 miles of plant) are:

Estimated Manpower Requirements:
Monthly Performance Test

System Engineer	Installer	City Representative
1 man day	1 man day	1 man day

Plus: ¼ man day each for each additional 50 miles of plant.

If the costs for a city representative (who might be, for example, a television repairman) are assumed to be $25 per day, monthly tests program costs are as follows:

Estimated Annual Costs—11 Monthly Tests

	Total Costs	Cost/Subscriber/Year
Small System	$1,100	$ .73
Large System	$2,922	$ .19

If the franchising authority waives the requirement that a city representative accompany the test team, test costs will be reduced—an approach that may be suitable for small or medium sized systems.

For small or medium sized systems, the franchising authority may further reduce costs by requiring that these tests be conducted quarterly or semi-annually rather than monthly.

Estimated Annual Costs—11 Monthly Tests Without City Representative

	Total Costs	Cost/Subscriber/Year
Small System	$1,100	$ .73
Large System	$2,338	$ .16

The proof of performance procedure discussed herein includes both objective and subjective test methods. Objective methods will be needed for assessment of a system with respect to various technical parameters. Subjective tests can be used as alternative, less expensive test procedures as long as the techniques can be demonstrated to provide reliable methods of assessment and can be related to objective measurements.

(a) Objective Tests

Objective, quantitative tests should be made for the following:

— measurements of signal level of video carrier on all active channels

— measurement of system signal to noise level on both a low and high VHF channel

— measurement of signal to hum level on any one system frequency.

The following ordinance provision will require these tests.

Suggested Provision:

D.08(a) The following proof of performance tests shall be made on a monthly basis to ensure compliance with applicable local performance standards: signal level of video carrier of each active channel; system signal to noise level measured at a low and high VHF channel and system signal to hum modulation measured at any one frequency.

D.08(b) Monthly proof of performance tests shall be made at all trunk amplifier and line extender amplifier test point locations specified in Section D.02(b)ii except that multitap testing is not required in the monthly tests. Measurements shall be taken and recorded at the above locations.

D.08(c) All monthly measurements noted in D.08(a) shall be made with test equipment meeting standards established in D.03.

D.08(d) These monthly proof of performance tests shall be made in a manner that does not cause any disruption of cable service to subscribers.

D.08(e) The Company's testing team shall be accompanied by a City representative while tests are conducted.

(b) Subjective Tests

The monthly proof of performance tests should also include visual observation of a color television monitor, and subjective analysis to measure intermodulation, color quality, echoes, and cross modulation.

These tests can be performed using subjective ratings, which are judgments of picture quality as observed on a television receiver. For many routine tests this is a satisfactory method. Unfortunately, these judgments will vary with individuals, type of programming, background lighting, and other factors. The only reliable method to ensure standards of performance is to relate these subjective judgments to quantitative ratings of the various distortions that can impair the picture. These are not subject to the factors mentioned above.

The subjective ratings in each category are based upon a format used by the Television Allocations Study Organization (TASO) for grading levels of picture quality. These ratings were reported to the FCC by TASO, March 1959. TASO's scale, which is based upon the responses of a panel of viewers, is illustrated below.

RATING	PICTURE QUALITY LEVELS
1 - Excellent	The picture is of extremely high quality.
2 - Fine	The picture is of high quality. Interference is perceptible.
3 - Passable	The picture is of acceptable quality. Interference is not objectionable.
4 - Marginal	The picture is poor in quality. Interference is somewhat objectionable.
5 - Inferior	The picture is very poor, but viewable. Definite objectionable interference is present.
6 - Unusable	The picture is not viewable.

The following suggested provision, which relates the above TASO scale to objective standards, requires that the subjective test be performed monthly.

Suggested Provision:

D.09(a) A monthly visual observation test using a color television monitor and a subjective analysis shall be made of cross modulation, color quality (luminance vs. chrominance); intermodulation of discrete beats and of thirty (30)

channel triple beat type, and echoes whether delayed or the leading type caused by direct pickup.

D.09(b) This visual observation test shall be related to the following chart:

Grade	Signal to Cross Modulation	Signal to Discrete Beat	Signal to 30 Channel Triple Beat	Signal to Echo	Luminance vs. Chrominance
1	52	60	52	40	1.5
2	46	52	46	34	2.0
3	40	44	36	28	2.5
4	34	36	30	22	3.0

D.09(c) The results obtained by this visual observation test shall meet at least a standard of Grade 2 or its equivalent objective measurement as indicated on the chart in D.09(b) for each of the measurements to be made, *except that* signal to echo may meet a Grade 3 standard.

D.09(d) This monthly proof of performance test shall be made at all trunk amplifier and line extender test point locations as specified in Section D.02(b)ii.

D.09(e) This monthly proof of performance test shall be made in a manner that does not cause any disruption of cable service.

D.09(f) The Company's testing team shall be accompanied by a City representative while tests are conducted.

4. Special Tests

In addition, the franchising authority should be empowered to request measurements when it has responsible evidence that system performance is deficient. Requests for special tests should be specifically limited to the suspected fault in question rather than an overall proof of performance. For example, if a franchising authority is troubled by complaints of direct pick-up interference, it might request a report and analysis covering this subject only, but not call for total performance testing. Such reports should be signed by a registered professional engineer, preferably not on the permanent staff of the franchisee. Provision for periodic tests and penalties for continued substandard service should be closely tied to procedures for handling consumer complaints in the day-to-day regulation portion of the ordinance.

Suggested Provision:

D.10(a) When there have been similar complaints made, or where there exists other evidence, which, in the judgment of the City, casts doubt on the reliability or quality of cable service, the City shall have the right and authority to compel the Company to test, analyze and report on the performance of the system. Such test or tests shall be made, and the reports of such test or tests shall be delivered to the City no later than 14 days after the City formally notifies the Company.

D.10(b) The City's right under this provision shall be limited to requiring tests, analyses, and reports covering specific subjects and characteristics based on said complaints or other evidence when and under such circumstances as the City has reasonable grounds to believe that the complaints or other evidence require that tests be performed to protect the public against substandard cable service.

D.10(c) Said tests and analyses shall be supervised by a registered professional engineer, not on the permanent staff of the Company, and selected jointly by the City and the Company. The aforesaid engineer shall sign all records of special tests and forward to the City such records with a report interpreting the results of the test and recommending actions to be taken by the City.

Since much of the discussion in this section dealt with the costs of various testing options, it may be useful to summarize the possibilities.

— Initial tests are the most costly, particularly for small systems. But from the city's point of view, they may also be the most important.

— Annual tests are not too expensive if done in conjunction with the FCC's annual tests.

— Monthly tests do much to insure that the system's performance is maintained at high levels during the year. But they may be an unfair burden upon a small system.

— Test costs depend heavily upon the rates charged by the independent engineer.

It should be noted that the cost implications of these tests may or may not affect system profitability. Operating expenses for most systems range between $20 and $40 per subscriber per year. The tests defined in this supplement thus might increase operating expenses by as little as 5%, or as much as 15%, depending on the system. Careful estimation of the precise impact may be the key to deciding upon the testing options.

E. PROOF OF PERFORMANCE—RECORDS

System performance records provide a basis by which the municipality can judge the capabilities of the equipment used, the efficiency of the overall design, how well the system operates at various ambient temperatures, whether installations were properly made, and whether customers are satisfied with their service.

Records themselves, however, do not accomplish any of these purposes. If the franchising authority does not establish a sensible procedure for evaluating records generated and acting on the information furnished, system performance testing and the records that result will collapse into a meaningless flow of paperwork that is harassing to the system operator.

The record keeping recommended in this part of the standards program is based on the assumption that initially, and at least once a year, the franchising authority will use the serivces of an engineer to review appropriate technical records kept by the system operator, test the cable system's performance as described earlier, and report to the franchising authority. Accordingly, the records described below are divided into two categories:

those furnished by the system operator, including

— a detailed technical description of the system
— customer satisfaction team reports
— monthly test reports
— system equipment change reports.

those furnished by an independent engineer, including

— initial proof of performance test report
— annual proof of performance test report
— reports of special tests.

Appendix B of this supplement, entitled "System Log Book," contains sample record keeping forms which the franchising authority may want to use to record the information, measurements and test results gathered during the tests required in Subsection D above.

1. Initial Testing—Records

The franchising authority should indicate in its regulatory ordinance a general provision requiring that records of required tests be set down and made available to it. The following provision should guarantee that all measurements required to be taken in the initial proof of performance testing be recorded and provided to the franchising authority.

Suggested Provision:

E.01(a) All tests and measurements required to be taken by the Company and the engineer in Subsection D of this Ordinance shall be recorded and submitted to the City within twenty (20) calendar days following the completion of initial proof of performance testing.

In addition, the franchising authority will want its cable system operator(s) to provide a thorough "portrait" of that system at the time the system is first being activated. The following provision requires such a technical report and details the specific information to be included within it.

Suggested Provision:

E.01(b) The Company shall prepare a technical report that describes details of the cable system as described in this Section. Two copies of said technical report shall be submitted to the City within twenty (20) calendar days following completion of the initial testing required in Section D.02(a) of this supplement. The technical report shall include the following details.

E.01(b)i Justification of the site selected, including:
- listing of television and FM radio stations carried on the system
- location of microwave terminals
- location of local origination centers
- location of antenna site
- distance from antenna site to farthest area served by the system
- height of tower
- height of antenna site in relation to average terrain
- accessibility of antenna site all year round
- local construction restrictions on tower
- power availability for antenna site
- location of antenna arrays on the tower
- direction of desired signal sources
- analysis of potential sources of interference in the nearby environment.

E.01(b)ii System information, including:
- statement of adherence to construction standards
- as-built drawings of the system
- description of local origination equipment
- signal level readings for all active channels at all amplifier locations; trunk input and output, and bridger output

— identification of trunk and feeder cables
— calculations of system temperature capabilities.

E.01(b)iii The following information for each signal to be received:

— signal level and quality of off-air channels
— analysis of interfering signals
— analysis of echoes on any locally receivable channels that are less than 34 dB down.

E.01(b)iv Description of each antenna array, including:

— mechanical
  configuration
  type of mounting
  method of stacking
  method of weatherproofing; method of preventing corrosion if applicable
  wind and ice loading capabilities
— electrical performance
  gain
  return loss in dB.

The key document in the initial proof of performance test is the report from the independent engineer. This report should include not only the test data, but also the engineer's professional judgment as to whether the tests indicate that the system meets performance standards.

Suggested Provision:

E.01(c) The engineer who supervises the conduct of initial proof of performance tests as prescribed in Section D, shall prepare a report which will include, but not be limited to, the following:

E.01(c)i A description of test equipment and procedures used.

E.01(c)ii Measurements of locally receivable signals as prescribed in Subsection B.02, and imported distant signals as prescribed in Subsection B.08(b).

E.01(c)iii An assessment of the picture quality available from the local origination equipment.

E.01(c)iv Measurements of system performance as prescribed in Section D.

E.01(c)v Measurements of system performance with respect to FCC technical standards specified under C.01(a).

E.01(c)vi Calculated performance of the system under different weather conditions:
—calculated signal to noise ratio of the normal daily maximum temperature in August
—calculated intermodulation at normal daily minimum temperature in February.

E.01(c)vii Statement of the cable system's adherence to construction and performance standards. If these are not satisfactory, a statement as to what items are to be corrected, and if necessary, recommendations as to action to be taken by the City.

2. Annual Testing—Records

As with initial testing, the franchising authority will want to have records of the results of the annual tests it requires of the franchisee. The following general provi-

sion will ensure that records of annual tests are kept and made available to the authority.

Suggested Provision:

E.02(a) All tests and measurements required to be taken by the independent engineer as prescribed in Subsection D.07 of this Ordinance should be recorded and submitted to the City within twenty (20) calendar days following the completion of the annual proof of performance testing.

There is no need for a technical report from the system operator for the annual tests. However, the franchising authority should require a report from the engineer who supervises the tests.

Suggested Provision:

E.02(b) The engineer who supervises the conduct of annual proof of performance tests as prescribed in Subsection D.07 shall prepare a report which will include, but not be limited to, the following:

E.02(b)i A description of test equipment and procedures used.

E.02(b)ii Measurements of locally receivable signals as prescribed in Subsection B.02, and imported distant signals as prescribed in Subsection B.07(b).

E.02(b)iii An assessment of the picture quality available from the local origination equipment.

E.02(b)iv Measurements of system performance as prescribed in Section D.

E.02(b)v Measurements of system performance with respect to FCC technical standards specified under C.01(a).

E.02(b)vi Calculated performance of the system under different weather conditions:
—calculated signal to noise ratio of the normal daily maximum temperature in August
—calculated intermodulation at normal daily minimum temperature in February.

E.02(b)vii Statement of the cable system's adherence to performance standards and if these are not satisfactory, a statement as to what items are to be corrected, and if necessary, recommendations as to action to be taken by the franchising authority.

3. Monthly Testing—Records

Records of monthly tests should also be made available to the franchising authority.

Suggested Provision:

E.03(a) All tests and measurements required to be taken monthly by the Company in Subsection D of this Ordinance shall be recorded and submitted to the City within seven (7) calendar days following completion of the monthly proof of performance testing.

The franchising authority will want information as to the quality of signals on the system. Therefore, the following provision should also be included in the regulatory ordinance.

Suggested Provision:

E.03(b) The Company shall prepare a monthly technical report which includes, but is not limited to, the following results, measurements, and information:

E.03(b)i Description of test equipment and procedures used.

E.03(b)ii Results of evaluations of system performance made on each active channel at those points designated and specified elsewhere in this Ordinance.

Such information shall be submitted to the franchising authority within seven days following completion of the monthly tests.

4. Special Tests—Records

Special tests are sometimes required when complaints, such as direct pickup interference in given areas, are received.

These special tests, which can be required by the franchising authority in some circumstances, should have the results reported in detail to the franchising authority. The franchising authority can generally require information and results concerning the nature of complaints, what system components were tested, the testing procedure used, and how the complaint was resolved, if, in fact, it was resolved. The following provision should ensure that the franchising authority has thorough records of the special tests it may require.

Suggested Provision:

E.04 Any special tests or measurements required by the City to be taken pursuant to Section D should be reported to the City within fourteen (14) days after such tests or measurements are performed. Such report shall include the following information: the nature of the complaint which precipitated the special tests; what system component was tested, the equipment used and procedures employed in said testing; the results of such tests; and the method in which such complaints were resolved. Any other information pertinent to the special test shall be recorded.

5. General Records Provisions

Finally, the francishing authority will be interested in learning about any major changes which occur in the system's carriage of channels or location of equipment. The following provision should assure the franchising authority's receipt of this information.

Suggested Provision:

E.05 Should any of the following occur, the Company must notify the City with particulars:

— addition to, deletion of, or change in received channel

— addition to, deletion of, or change in distributed channel or in channel conversion
— change in location of headend or antenna sites
— addition to or changes in location of centers for origination of programs, and the installation of bi-directional facilities or additional lines to make connection to the headend
— interconnection with other cable systems.

APPENDIX A:
TEST AND MEASUREMENT PROCEDURES

Introduction

Procedures for testing most of the performance characteristics outlined in this supplement are well understood in the cable television industry. However, there are some inexpensive and reliable testing procedures for standards which are not widely understood or agreed upon. The procedures outlined in this section deal only with that category of standards. They are described not only for the franchising authority but also for the system operator who may not be familiar with testing procedures.

A. Off-Air Video Signal To RMS Noise

A suggested test procedure is as follows:

1. Connect the antenna down lead of the channel under test to the input of a demodulator. This measurement is made during normal viewing time when noise sources are active. The input video carrier level should be five dBmV or more.
2. Connect the video output of the demodulator, at a level of one volt peak-to-peak, to the vertical input of a waveform monitor and tune the monitor to an unmodulated line during the vertical blanking interval.
3. Adjust the vertical gain of this monitor such that the black to white level requires full scale deflection and measure the magnitude of the quasi peak-to-peak noise superimposed on the unmodulated line.
4. Calculate the video signal versus the RMS noise. For example: the measured quasi peak-to-peak noise is one-half division of eight on the monitor. This is 6.25 per cent or -24 dB.[1] A 14 dB[2] correction factor results in a 38 dB ratio.

B. Off-Air Signal To Hum Modulation

A suggested test procedure is as follows:

1. Connect the RF input of a signal strength meter to the antenna down lead of the channel under test.
2. Connect the video output of this meter to an oscilloscope that has both AC and DC vertical amplifier inputs.
3. Tune the meter to the video carrier of the desired channel and, with the oscilloscope in DC position, measure the ratio (dB) between this carrier and any superimposed low frequency AC modulation.
4. The signal to hum modulation is the ratio of the carrier level to the peak-to-peak hum modulation in conformance with 47 C.F.R. 76.605(a)(7).

For detailed procedures, refer to:

Ken Simons, *Technical Handbook for CATV Systems* (Philadelphia: Jerrold Electronics Corp., 1968) pp. 54, 55; 3rd Edition.

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[1] Ken Simons, *Technical Handbook for CATV Systems* (Philadelphia: Jerrold Electronics Corp., 1968), p. 89.

[2] B. W. Osborne, *Color TV Reception and Decoding* (New York: Hart Publishing Co., 1968), p. 16.

C. Off-Air Signal To Interfering Signal

A suggested test procedure is as follows:

Connect the antenna down lead of the channel under test to a test instrument. Measure the signal level of the desired channel and measure the magnitude of undesired signals within the passband. Their difference (dB) is the signal to intermodulation ratio.

Some test instruments with this capability are the spectrum analyzer, the wave analyzer, or a combination of field strength meter and frequency selective voltmeter.

D. Off-Air Signal to Echo

A suggested test procedure is as follows:

1. Connect the antenna down lead to the input of a demodulator that has an Xtal controlled tuner for the desired channel.
2. Feed the demodulated video signal via a calibrated attenuator to a waveform monitor that is capable of displaying the 2T sin squared pulse which is transmitted as one of the vertical interval test (VIT) signals.
3. Insert 20dB into the attenuator and display this pulse full scale on the monitor and at the left of the screen such that 5.0 micro-seconds can be seen. (Even if loss of high frequency response has reduced amplitude of pulse, the only concern in this test is relative amplitude of desired pulse to reflected-pulse.)
4. Remove 20 dB pad to increase sensitivity of test procedure and measure reflection(s) by using waveform monitor as an electronic voltmeter. Add 20 dB to the dB measurement in amplitude reduction of reflection vs. original pulse.
5. Calibrate horizontal time domain display of waveform monitor to measure displacement time of echo. Ignore echoes within one micro-second as they may be distortions introduced by the demodulator.
6. The relative amplitude (dB) of the reference pulse versus the delayed pulse(s) is the signal to echo ratio.

E. Off-Air Luminance vs. Chrominance

A suggested test procedure is as follows:

1. Connect the antenna down lead of the desired channel to the input of a demodulator that has an Xtal controlled tuner.
2. Connect the video output at one-volt peak-to-peak level to the input of a waveform monitor or an oscilloscope that has a vertical amplifier bandwidth of at least five MHz.
3. Tune the oscilloscope to a single horizontal sync pulse, expand gain of the oscilloscope and measure the respective amplitudes (ignoring displacement) of the peak-to-peak color burst versus the peak sync pulse.
4. The sync pulse provides a low frequency reference (15.734 KHz). The color burst provides a high frequency reference (3.58 MHz). The FCC's transmission standards recommend that they be within one dB of each other in magnitude. Therefore, this test provides a means of measuring any additional reduction of high frequencies (chrominance) with respect to low frequencies (luminance).

F. System Signal to Echo

A suggested test procedure is as follows:

1. Calibrate test equipment

(a) Feed the composite sync and 2T $\sin^2$ pulse, video test signal from an NTSC signal generator to the input of a television modulator at a signal level of one volt peak-to-peak.

(b) Modulate at 87.5 per cent, a low VHF channel. Attenuate this RF output to +10 dBmV and feed to a TV demodulator with Xtal input tuner.

(c) Connect video output of demodulator through a calibrated attenuator to a waveform monitor which is capable of displaying the sin squared pulse.

(d) Insert 20 dB into attenuator and display this pulse full scale on the monitor and at the left of the screen such that five micro-seconds can be seen.

(e) Remove 20 dB pad and check for magnitude of any reflections beyond one micro-second. This provides a reference for later testing of overall system.

2. Measurement of amplitude and displacement of echoes in overall system.

(a) Feed the composite sync and 2T sin squared pulse video test signal from an MTSC signal generator to the input of a television modulator at a signal level of one volt peak-to-peak.

(b) Modulate at a level of 87.5 per cent, a low VHF channel and mix this signal with the combined output of the other signal processors at the headend and at the same signal level as that of the other low VHF channels.

(c) At a system trunk extremity, connect a test point output to the input of a television demodulator that has an Xtal tuner (to ensure accurate tuning).

(d) Connect video output of demodulator through a calibrated attenuator to a waveform monitor capable of displaying the sin squared pulse.

(e) Insert 20 dB into attenuator and display this pulse full scale on the monitor and at the left of the screen such that five micro-seconds can be seen.

(f) Remove 20 dB pad and check for magnitude of any reflections displaced one micro-second or more as compared with the magnitude of the reference pulse.

(g) The ratio of amplitude of reference pulse to that of reflected pulse less 20dB is the signal to echo ratio.

G. System Luminance vs. Chrominance Amplitude

1. Connect a system extremity test point output to the input of a television demodulator that has an Xtal controlled tuner for each channel to be tested.

2. Feed the demodulated video signal via a calibrated attenuator to a waveform monitor or an oscilloscope that has five MHz or more of vertical amplifier bandwidth.

3. Tune to a single horizontal sync pulse and measure the respective amplitudes (ignoring displacement) of the peak sync pulse vs. the peak-to-peak 3.58 MHz color burst.

4. This relative amplitude is the ratio (dB) of luminance vs. chrominance.

5. Repeat for all active channels that provide color programming.

APPENDIX B:
SYSTEM RECORDS LOG BOOK

INTRODUCTION

The importance of keeping system records cannot be overemphasized. An up-to-date accurate and complete set of records is the key to pinpointing the cause of trouble and keeping maintenance to a minimum.

SYSTEM LOG BOOK

A log book should be maintained for every system. The sample record keeping forms which follow will provide the information required by the franchising authority as described in Section E, dealing with proof of performance records.

DESCRIPTION	SYSTEM LOG BOOK	REFERENCE
Technical Report		
Summary Sheet	Form 1	E.01(b)i
Justification of Site Selection	Form 2	E.01(b)i
System Information		
Statement of Adherence to Construction Standards	Form 3	E.01(b)ii
As-built Drawings and Maps of System	Form 4	E.01(b)ii
Description of Local Origination Equipment	Form 5	E.01(b)ii
Trunk Amplifier Signal Levels	Form 6	E.01(b)ii
Feeder Amplifier Signal Levels	Form 7	E.01(b)ii
Cable Identification at Trunk Locations	Form 6	E.01(b)ii
Off-Air Reception		
Signal Levels and Quality of Off-Air Channels	Form 8	E.01(b)iii
Analysis of Interfering Signals	Form 9	E.01(b)iii
Analysis of Echoes less than -34 dB	Form 10	E.01(b)iii
Description of Antenna Array	Form 11	E.01(b)iv
Temperature versus Performance of System		
Calculations as to System Temperature Capabilities	Form 12	E.01(b)ii
Initial Proof of Performance		
Compliance with FCC Standards	Form 13	E.01(c)v
Evaluation of Reception of Locally Received Signals	Form 8	E.01(c)ii
Evaluation of Overall System Performance	Form 14	E.01(c)iv
Signal Levels at Multitaps	Form 15	E.01(c)iv

Calculations of System Performance vs. Temperature	Form 12	E.01(c)vi
Description of Test Equipment and Procedures	Form 15	E.01(c)i
Assessment of Local Origination Picture Quality	Form 16	E.01(c)iii
Statement of Cable System Performance	Form 17	E.01(c)vii
Annual Proof of Performance		
Compliance with FCC Standards	Form 13	E.02(b)v
Evaluation of Reception of Locally Received Signals	Form 8	E.02(b)ii
Evaluation of Overall System Performance	Form 14	E.02(b)iv
Calculations of System Performance vs. Temperature	Form 12	E.02(b)vi
Description of Test Equipment and Procedures	Form 15	E.02(b)i
Assessment of Local Origination Picture Quality	Form 16	E.02(b)iii
Statement of Cable System Performance	Form 17	E.02(b)vii
Monthly Proof of Performance		
Description of Test Equipment and Procedures	Form 15	E.03(b)i
Evaluation of Overall System Performance	Form 18	E.03(b)ii
Special Tests	Form 19	E.04
Customer Complaints	Form 20	E.04
System Changes	Forms 1 and 4	E.05

Form 1

SUMMARY SHEET

Name of local cable company _____
Address of local cable company _____

Name of corporation _____
Address of main office _____

Name of engineer _____
Address of engineer _____

Name of principal community served _____
Number of households within cable system service area _____
Number of strand miles within cable system service area _____
Number of subscribers now served _____
Location of local origination center(s) _____

Location of terminals of microwave links; longitude and latitude of each:

_____ Long._____ Lat._____
_____ Long._____ Lat._____
_____ Long._____ Lat._____

List of TV and FM Signals Carried

Call Letters	Broadcast Station Location	Azimuth and Distance (Antenna Site to Station)	Received Channel	Distributed Channel	Grade

_____ Date

_____ Name

_____ Title

Form 2

JUSTIFICATION OF SITE SELECTION

Name of cable company _____
Location of antenna site _____
Power availabiilty for site _____
Height of site above average terrain _____
Accessibility of antenna site all year _____
Direction of signal sources _____

Analysis of potential sources of interference in nearby environment.

Local airport or construction restrictions on tower.

Distance (miles) from antenna site to nearest distribution to subscribers. _____

Distance (miles) from site to farthest subscriber terminal location served by the system. _____

Distance to hubs. _____

Height of tower. _____

Location of antenna arrays on tower. _____

_____ _____

Date Name

_____

Title

Form 3

ADHERENCE TO CONSTRUCTION STANDARDS

The cable television system constructed for the City of _____

by _____

meets all safety and reliability standards as prescribed in Section A of "Technical Standards and Specifications."

_____ _____

Date Name

_____

Title

Form 4

AS-BUILT DRAWINGS AND MAPS

Attached are strand maps and maps of all electronic equipment as installed in the City of _____

_____ by _____

_____ _____

Date Name

_____

Title

Form 5

LOCAL ORIGINATION EQUIPMENT

Automatic cablecasting services (identify color or monochrome).

Local origination centers--location, type of equipment, and service functions.

Public access--location and type of equipment.

Mobile van(s) equipment available.

Date

Name

Title

Form 6

TRUNK AMPLIFIER SIGNAL LEVELS

Date_____ Temp._____

Amp. location _____

Signal Levels (dBmV)

Channel	Amplifier Input Test Point	Amplifier Output Test Point	Bridger Test Point	Channel	Amplifier Input Test Point	Amplifier Output Test Point	Bridger Test Point
2				C			
3				D			
4				E			
5				F			
6				G			
7				H			
8				I			
9				J			
10				K			
11				L			
12				M			
13				N			
A				O			
B				P			

Feeder Identification	
Number	Feeder Terminates at:
1	
2	
3	
4	
	Q
	R
	S
	T
	U

Remarks:_____

_____

_____

_____
Name

_____
Title

Form 7

FEEDER AMPLIFIER SIGNAL LEVELS

Date _____ Temp. _____
Line extender location _____

Signal Levels (dBmV) | Signals Levels (dBmV)

Channel	Input Test Point	Output Test Point	Channel	Input Test Point	Output Test Point
2			A		
3			B		
4			C		
5			D		
6			E		
7			F		
8			G		
9			H		
10			I		
11			J		
12			K		
13			L		
			M		
			N		
			O		
			P		
			Q		
			R		
			S		

Remarks: _____

_____ Name

_____ Title

Form 8

SIGNAL LEVELS AND QUALITY OF OFF-AIR CHANNELS

Date _____ Temp. _____

Chan-nel	Video R.F. Signal (dBmV)	Audio R.F. Signal	Vid. Sig. to RMS Noise	Hum Mod. %	Signal to Echo	Luminance to Chrominance
VHF						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
UHF						

Remarks: _____

_____

_____

_____
Name

_____
Title

Form 9

ANALYSIS OF INTERFERING SIGNALS

Date _____ Temp. _____
Weather conditions _____
Desired channel off array _____
Video R.F. _____ Audio R.F. _____

Interfering Channels (Signals) Off Same Array

Channel	Video R.F.	Audio R.F.	To minimize interference, these are Trap, Filter, Preamplifier requirements
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
FM			
FM			
FM			
FM			

Recommendations: _____

_____

_____

_____
Name

_____
Title

Form 10

ECHO ANALYSIS (less than -34 dB) ON LOCALLY RECEIVABLE CHANNELS

Date _____ Temp. _____

Channel	Signal to Echo	Echo Displacement	Echo Source	Signal to Echo on Search Antenna	Remarks
					a b c d

Discuss how array was designed to reduce echo and suggested further remedy:

(a)

(b)

(c)

(d)

Name

Title

Form 11

DESCRIPTION OF ANTENNA ARRAY

Date_____ Temp._____
Weather conditions_____

Mechanical:

Type of antenna _____
Height on tower _____
Direction oriented _____
Type of mount _____
Stacking of array _____
Horizontal spacing of antennas _____
Vertical spacing of antennas _____
Mixing device _____
How weatherproofed _____
_____
Antenna corrosion protection _____

Electrical:

Gain of array (dB) _____
Return loss of array as mounted _____
Measured signal off-array at video carrier_____ Audio carrier_____
Measured signal off search antenna at video carrier_____ Audio carrier_____

Remarks:_____
_____
_____
_____
_____
_____

_____
Name

_____
Title

Form 12

SYSTEM PERFORMANCE VS. TEMPERATURE

Normal daily maximum ^{O}F in August_____
Normal daily minimum ^{O}F in February_____
Measured temperature of system during test_____
Maximum minus measured = Temperature correction for signal/noise_____
Measured minus minimum = Temperature correction for intermodulation_____
Cable varies approximately .001 per dB of cable per ^{O}F.
Engineering information from suppliers as to equipment and system variation in signal levels with temperature and effect of system design automatic slope and gain control.

_____
_____
_____
_____
_____

Measured signal/noise during system test _____ ^{O}F
Measured signal/intermodulation during system test _____ ^{O}F
Calculated signal/noise at normal daily maximum (Aug.)_____ ^{O}F
Calculated signal/intermodulation at normal daily minimum (Feb.)_____ ^{O}F

Remarks:_____
_____
_____
_____
_____

_____ _____
Date Name

_____
Title

COMPLIANCE WITH FCC TECHNICAL STANDARDS

Channel	Visual Carrier Frequency (MHz)	Aural Carrier Frequency (MHz)	Visual Signal Level (dBmV)	Aural Signal Level (dBmV)	Signal to Hum (dB)	Response Peak/Valley @ -1 to +4 MHz	Signal Noise (dB)	Signal Co-Channel (dB)	Signal/ Inter-modulation (dB)	Terminal Isolation (dB)	Radia-tion (dB)
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											
K											
L											
M											
N											
O											
P											
Q											
R											

The cable television system of the City of _____ has been tested during the period of _____ to _____ and meets FCC "Technical Standards" Subpart K #76.605 as measured in accordance with "Measurements" 76.609.

_____
Name

_____
Title

_____
Date

Form 14

EVALUATION OF OVERALL SYSTEM PERFORMANCE

Date _____ Temp. _____

Channel	Video Carrier Signal Level	Signal to Noise	Signal to Hum	Signal to Intermodulation	Signal to Echo	Luminance to Chrominance
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
A						
B						
C						
D						
E						
F						
G						
H						
I						
J						
K						
L						
M						
N						
O						
P						
Q						
R						
S						

The cable system installed in the City of _____ by _____ meets the above performance standards as specified in Section C of "Technical Standards and Specifications" at the above location for the initial ☐ annual ☐ test.

Date _____

_____
Name

_____
Title

Form 15

DESCRIPTION OF TEST EQUIPMENT AND PROCEDURES

TEST EQUIPMENT:

Function	Mfg.	Model	Serial Number	Most Recent Calibration	Calibrated By:

PROCEDURES:

The test procedures for FCC Standards conform with Subpart K, "Measurements" 76.609. Yes ☐ No ☐

If not explain:

The test procedures for additional technical standards conform with Appendix "A". Yes ☐ No ☐

If not explain:

Date _____

_____
Name

_____
Title

Form 16

ASSESSMENT OF LOCAL ORIGINATION PICTURE QUALITY

Location of studio_____
Type of equipment_____
_____
_____

Does ...pment deliver EIA sync? Yes [ ] No [ ]
Are ... problems of flogging with VTR's Yes [ ] No [ ]

What is per cent modulation?_____

How linear?_____

Is audio satisfactory? _____

Is picture quality satisfactory?_____

Recommendations:_____
_____
_____
_____
_____
_____

_____ _____
Date Name

_____
Title

Form 17

STATEMENT OF CABLE SYSTEM PERFORMANCE

The cable television system constructed, installed and being operated for the City of_____

_____ by _____

_____ has [ ] has not [ ] met all performance standards; those specified by the Federal Communications Commission, Subpart K and those additional technical standards prescribed in this Ordinance.

If standards have not been met describe failures: _____

_____

_____

_____

_____

Recommended action by City. _____

_____

_____

_____

_____ _____

Date Name

_____

Title

Form 18

EVALUATION OF OVERALL SYSTEM PERFORMANCE MONTHLY

Amplifier Location _____ Date _____ Temp. _____

	Objective Test			Subjective Test (Grade)				
Channel	Video Carrier Signal (dBmV)	Signal to Noise (dB)	Signal to Hum (dB)	Signal Cross Mod	Color	Discrete Beats	Multiple Triple Beats	Echoes
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
A								
B								
C								
D								
E								
F								
G								
H								
I								
J								
K								
L								
M								
N								
O								
P								
Q								
R								
S								
T								
U								
V								
W								

Name _____

Title _____

Form 19

SPECIAL TESTS

Type of system complaints _____

Background information:

Subscribers names	Addresses
_____	_____
_____	_____
_____	_____
_____	_____

Work done to date to correct deficient performance:

_____
_____
_____

Test made as to justification of complaints:

_____
_____
_____

Results of tests:

_____
_____
_____

Recommendations as to action to be taken by cable system operator:

_____
_____
_____

Recommendations as to action to be taken by City:

_____
_____
_____

_____ _____

Date Name

_____

Title

Form 20

CUSTOMER COMPLAINTS

Subscriber name _____

Address _____ Telephone number _____

Complaint reported date _____ Time _____

TROUBLE REPORTED (Check one)		
No pix - one channel ☐	Screen dark ☐	Interference (one) ☐
No pix - all channels ☐	Snowy (one) ☐	Interference (all) ☐
Pix - no sound (one) ☐	Snowy (all) ☐	Ghosts (all) ☐
Pix - no sound (all) ☐	Ghosts (one) ☐	

Other trouble: _____

_____

Corrected Signal After Service					
Channel	Pix Quality	Signal	Channel	Pix Quality	Signal
2			F		
3			G		
4			H		
5			I		
6			J		
7			K		
8			L		
9			M		
10			N		
11			O		
12			P		
13			Q		
A			R		
B			S		
C			T		
D			U		
E					

Action Taken: _____

_____

_____

_____

Is complaint satisfied? Yes ☐ No ☐

Recommended future action: _____

_____

_____

Cleared: Date _____ Time _____

Time spent: _____